Course Title: **Radiological Control Technician**
Module Title: **Air Sampling Equipment**
Module Number: **2.18**

Objectives:

2.18.01 Identify the factors that affect the operator's selection of a portable air sampler.

⇒ 2.18.02 Identify the physical and operating characteristics and the limitation(s) of the Staplex and Radeco portable air samplers.

⇒ 2.18.03 Identify the physical and operating characteristics and the limitation(s) of Motor air pumps.

⇒ 2.18.04 List the steps for a preoperational checkout of a portable air sampler.

⇒ 2.18.05 Identify the physical and operational characteristics and the limitation(s) of beta-gamma constant air monitors (CAM's).

⇒ 2.18.06 Identify the physical and operating characteristics and the limitation(s) of alpha constant air monitors (CAM's).

References:

1. "Radiation Detection and Measurement," Glenn F. Knoll, 1979.
2. "Basic Radiation Protection Technology," Daniel A. Gollnick, 1988.
3. "Operational Health Physics," Harold J. Moe, 1988.
4. ANSI N323A
5. (Various Manufacturers Technical Manuals)

Instructional Aids:

1. Overheads
2. Overhead projector/screen
3. Chalkboard/whiteboard
4. Lessons learned

I. MODULE INTRODUCTION

A. Self-Introduction

1. Name
2. Phone number
3. Background
4. Emergency procedure review

B. Motivation

Before the proper internal exposure control methods can be determined for personnel, an estimate of the airborne radioactivity concentration must be obtained. Airborne radioactivity measurements are necessary to ensure that the control measures are effective and continue to be effective. This lesson contains information about widely used air sampling equipment.

C. Overview of Lesson

1. Selection of portable air samplers
2. Physical and operating characteristics and limitations
3. Preoperational checkout of portable air samplers
4. Beta-gamma constant air monitors

D. Introduce objectives — O.H.: Objectives

II. MODULE OUTLINE

NOTE: The text is provided for some commonly used instruments. The site must adjust text as necessary for instruments used at each site. Text added for specific instruments used at the site must, at a minimum, cover material required by the objectives.

A. Factors Affecting the Selection of Portable Air Samplers — Objective 2.18.01

1. Type of radiation emitted by airborne contaminant in question
2. Physical state of airborne contaminant
3. Type and duration of job being performed — Objective 2.18.02

B. Physical and Operating Characteristics and Limitations

1. Staplex

a. Operational characteristics

1) Centrifugal force is the method used to induce air movement

a) Centrifugal force produces kinetic energy

b) Resultant velocity pressure converted to suction for moving sampled air

2) Self-cooling

a) Inappropriate for long-term continuous sampling

3) Variable orifice flowmeter calibrated 0-70 cfm

a) Flow rate sticker on side is specific for appropriate collection method

b) Typical flow rate(s): 7-28 cfm

b. Physical characteristics

1) 110-V fan motor with on-off switch

a) Requires external power source

2) 4-inch filter holder assembly with intake screen

a) MSA charcoal adaptor available

3) Portable: 10 pounds

c. Limitations

1) Inappropriate for long-term continuous sampling

2) May create an airborne area due to exhaust

3) Potential "crawler" while in operation due to the high torque generated by the fan

4) DO NOT use in explosive atmospheres

d. Methods of sampling

1) Filtration

2) Absorption, if charcoal is used

3) Impaction, if impactor head is installed

e. Placement for surveys

1) Avoid creating airborne activity through stirring up dust with sampler exhaust air

2) Tripods available

3) May be hung on chain for optimum positioning

f. Annular Kinetic Impactor Head

1) Inertial Collector-Head collects large airborne particles such as plutonium without collecting coexisting particles containing radon and thoron

2) Principle: Air to be sampled enters annular space at rear, makes a 180-degree turn at greased planchet, and out the center tube

3) Operational characteristics

a) Size of particles collected can be varied by adjusting slit width and air flow velocity

4) Physical characteristics.

a) Head replaces Staplex screened intake orifice

b) Lightly greased planchet placed on head intake

2. Radeco (H809-VI) Objective 2.18.02

a. Operational characteristics

1) Equipped with rotameter air flow indicator

a) Rotameter consists of

(1) A "float" which is free to move up and down

(2) A vertical tapered tube, which is larger at top than bottom and contains the float

b) Operates using air pressure

(1) Air flows up the tube

(2) Causes float to rise

(3) Height to which float rises is proportional to air flow rate

c) Many different types of floats

d) Rotameters are conventionally read at the highest point of maximum diameter, unless otherwise indicated

e) If in doubt about how to read a particular rotameter, check with supervision or Works Engineering Mechanic

2) Flow rate adjustable from 1 to 8 cfm

3) 110-125 VAC

b. Physical characteristics

1) Equipped with a two-stage turbine blower and one horsepower self-cooling universal type motor

2) Sample head uses 2 in. or 47 mm particulate and iodine filters

3) Instrument panel

a) Three-position switch - HIGH/OFF/VARIABLE

b) Control knob for FLOW ADJUST

c) Fuse holder

d) Rotameter

4) Weight: 10 lbs

c. Limitations

1) Cannot be used in explosive atmospheres

2) Inappropriate for long-term continuous sampling

d. Methods of sampling employed

1) Filtration

2) Adsorption, if charcoal is used

C. Motor Air Pumps — Objective 2.18.03

1. Types of motor air pumps.

a. MotoAir

b. ITT

c. Eberline

2. These units normally used to sample for extended periods of time at low flow rates

3. Operational characteristics of typical motor air pumps.

a. Flow rate maintained relatively constant by regulator

b. Requires 110 V power supply

4. Physical characteristics of typical motor air pumps

a. Sample heads used designed to accept 2 in. diameter (47 mm) media for both particulates and iodine

b. Common components

1) Carbon vane pump

2) Constant flow air regulator

3) Flow meter

c. Grounded three wire power cord is provided

5. Typical features - Eberline RAS-1

a. Operational characteristics.

1) Rotameter type flow meter

2) Flow rate range 0.5 to 3.5 cfm

3) Power requirement 5 amps

b. Physical characteristics

1) "Screw in" type particulate filter holder

2) "Clamshell" type iodine filter holder

3) ON/OFF power switch

4) Weight: 30 pounds

6. Sampling considerations

a. Filter paper must cover intake screen

b. Charcoal cartridge holder must have good seal

c. Check flow rate after turning on and before turning off

7. Reading a rotameter

a. Rotameter consists of

1) A "float" which is free to move up and down

2) A vertical tapered tube, which is larger at top than bottom and contains the float

b. It operates using air pressure

1) Air flows up the tube

2) Causes float to rise

3) Height to which float rises is proportional to air flow rate

c. Rotameters are conventionally read at the highest point of maximum diameter, unless otherwise indicated.

D. Preoperational Checkout of Portable Air Samplers — Objective 2.18.04

1. Current Calibration Sticker

2. Physical Damage

a. Power cord in good condition

b. All gaskets in place

c. General physical condition

1) Housing

2) Controls

3. Working Condition

a. Operates properly

1) Sound - no unusual noises

2) Sight - no smoke, no excessive sparking from motor brushes

3) Smell - no burning

4) Feel - no unusual vibration, not overly hot to touch

b. Appropriate air flow

c. Controls on sampler are operable

d. Ensure filters and cartridges are loaded in proper orientation to air flow prior to sampling

E. Beta-gamma Constant Air Monitors (CAM's) Objective 2.18.05

1. General Characteristics

a. Function

1) Continuously monitor quality of particulate beta-gamma airborne activity in selected area

b. Physical characteristics

1) GM detector(s) - usually pancake type

a) Some utilize one GM detector to measure activity on filter

b) Other utilize two GM detectors

- One GM detector to measure activity on filter

- Other GM detector to measures ambient background for background subtraction

2) Filter paper holder assembly in lead shield

3) Strip chart recorder

4) Mounted on enclosed, portable cart

5) Photohelic air flow meter

6) Alarm lights

a) High Activity alarm

b) Low air flow alarm

c. Limitations of CAM's

1) Low air flow

a) Must be placed near or downwind suspected source

2) Poor response to low energy beta

3) Lead shield ineffective for high gamma energies

a) CAM must be in low background

4) Responds to radon, thoron, and daughters

a) Produces fluctuating background on recorder

5) Not very portable

a) Approximate weight 500 pounds

d. Method of sampling - filtration

e. Operation and use

1) Initial startup

a) Check all switches in off position

- Master switch

- HV switch

b) Plug in power cord (110 V)

- Air blower will start
- Reset any alarms that activate

c) Ensure sufficient filter paper

d) Turn master switch on and allow two minute warmup

e) Turn HV switch on and allow 30 second warmup

f) E & I to adjust the following settings

- HV level
- High and low level alarm settings
- Scale switch overlap setting

g) Set recorder speed selector switch

- 3/4 in. per minute to ascertain chart moves
- 3/4 in. per hour, routine operation

h) CAM operating if slow buildup noted on recorder chart

F. Alpha Constant Air Monitors (CAM'S) Objective 2.18.06

Continuously monitor quality of particulate alpha airborne activity in selected areas

1. Operating characteristics

   a. Air pumping system pulls air through impactor head

   b. Count rate meter monitors planchet which will activate high activity alarm horn and light at preset points

2. Physical characteristics

   a. External cabinet features

      1) Power Supply

2) Magnehelic gauge

3) Count rate meter (CRM)

4) Recorder chart

5) Power switches

6) Outlets

7) Photohelic air flow meter

8) Alarm lights

a) Radiation alarm

b) Low flow alarm

b. Internal cabinet features

1) Annular Kinetic Impactor sample head

2) Blower

3) Planchet (greased with ZnS and Silicone)

4) Photomultiplier (PM)

3. Limitation(s)

a. Does not give extremely accurate quantitative alpha measurement

1) Gives warning of increase activity

2) Possible to make estimates

b. Dust buildup and radon-thoron activity affect efficiency

4. Method of sampling - Impaction

5. Operation and Use

a. Initial startup

1) Place new "Alpha Tak" planchet on impactor head

a) Open light tight box door

b) Move PM tube housing from impactor head

c) Remove any used planchet

d) Place new planchet on impactor head

e) Move PM tube housing back into position

f) Close door

g) Indicate action on recorder chart.(date, time, etc.)

h) Take any used planchets to RC office for processing

2) Plug in power cord ensuring all switches are off prior to plugging power cord in

3) Turn on switches in following order

a) Outlet switch

b) CRM power switch

4) Set CRM to x 1 scale

5) Set alarm to desired level

6) Set CRM PHA/GROSS switch to GROSS

7) Notify E & I and/or supervisor of any malfunctions

III. SUMMARY

A. Review major topics

1. Selection of portable air samplers

2. Physical and operating characteristics and limitations

3. Preoperational checkout of portable air samplers

4. Beta-gamma constant air monitors

B. Review learning objectives

IV. EVALUATION

Evaluation should consist of a written examination comprised of multiple choice, fill-in the blank, matching and/or short answer questions. 80% should be the minimum passing criteria for examinations.

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